HOW TO CHOOSE THE BEST TYPE
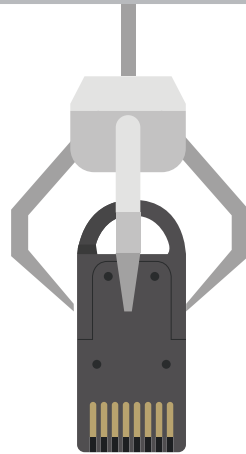
OF

REMOVABLE MEMORY DEVICE

FOR YOUR EMBEDDED SYSTEM

Datakey ®

The power of memory. Secreted.

THE REMOVABLE REVOLUTION

These days, there are literally thousands (if not millions) of uses for removable memory devices – pretty much any embedded system you can think of will utilise some form of removable technology.

And as time has gone on, the options available to the designer have increased – you're able to choose from a variety of USB flash drives and SD card solutions. Many of these are 'standard' and 'universal', while others are "non-standard", abandoning the standard form factors for reasons of robustness or security.

While the expansion of options is a blessing, it can also be a curse, as it's hard enough designing an embedded system without weighing up all the different types of memory available.

However, if you're serious about building something that performs its function AND stands the test of time, then that weighing up process has to happen.

And that's why we've put this guide together – to make the process as easy as possible for you.

WHY REMOVABLE MEMORY STILL EXISTS IN A CLOUD-BASED WORLD

Yes, the cloud has changed things, with an increase of internet-connected embedded applications, which automatically transfer data to and from the Cloud.

However, many of these devices (even the cloud-connected IoT ones) use removable memory devices for a variety of applications – data logging, firmware updates, secure boot and much more.

So, although in theory the Cloud has changed the fact of data storage and transfer, a vast number of applications still rely on some form of removable memory, and will continue to do so for the foreseeable future.

IS IT AS SIMPLE AS SD VS USB?

Historically, SD cards were more easily integrated with microcontroller-based embedded designs than USB flash drives, as only an SPI port was required to interface to an SD card.

In contrast, supporting a USB flash drive required the microcontroller-based design to function as a USB host.

While not common just a few years ago, today a variety of microcontrollers are available with built-in USB host capability, making both of these removable memory devices available to embedded system designers.
But the choice is more complicated and the options are more plentiful than simply choosing between using a USB flash drive or an SD card.

WHAT SHOULD YOU BE CONSIDERING WHEN DECIDING ON REMOVABLE MEMORY?

When choosing which type of SD card or USB flash drive to include in an embedded design, the design team should review the following list of design considerations and determine which features of the memory device and its receptacle are most important.

- Communications Interface/Protocol
- Cost
- Data Throughput Speed
- Environmental Ratings
- Ergonomic Factors
- Footprint of Receptacle Connector
- Insertion/Removal Cycle Life
- Memory Capacity
- Number of Write Cycles
- Physical Size of Memory Device
- Product Availability
- Product Life Cycle/Longevity
- Receptacle Connector Durability
- Ruggedness of Memory Device
- Security Features

Sorting the above list of design considerations in order of priority for a given application will help you determine which type of memory device is the best choice for their embedded product.

WHAT ARE YOUR OPTIONS?

After you've decided on your design priorities, it's time to consider which categories you've got available to you.

It's important to think this bit through properly, as not all flash drives or SD cards are created equal. Generally speaking, there are three categories of removable memory:

STANDARD CONSUMER

These are the products that most people picture when someone mentions a USB flash drive or SD card.

They come in the standard shapes: SD card and microSD card form factors for Secure Digital devices and flash drives with standard USB Type A or USB Type C connectors.

For some brands/models of flash drives and SD cards, low cost is the driving factor, often at the expense of quality, performance and long-term reliability.

Other brands focus on supporting the latest standards and/or providing the best performance.

Some of the better-known brands in the Standard Consumer group include SanDisk, Samsung, PNY and Transcend. There are also dozens of other manufacturers in this group producing products of varying quality. These products can be purchased online and at retail stores.

STANDARD INDUSTRIAL

These USB and SD card devices come in the standard form factors but are intended for non-consumer embedded applications.

They often utilise more robust memory, using SLC or MLC NAND flash over the more consumer-focused TLC NAND flash.

Many also work in more extreme temperatures, supporting the -40°C to +85°C industrial temperature range. They may also be offered with a fixed bill-of-materials (BOM).

On an SD card, for example, a fixed BOM would typically mean that the NAND flash, the controller IC and its firmware would all be fixed.

Any change would require an end of life notification, last time buy and release of a new replacement part number.

Some of the suppliers in the Standard Industrial Group include Swissbit, Panasonic, Cactus Technologies, Delkin and others. These products are typically sold through electronic component distributors (like Arrow, Avnet, Digi-Key, etc.) and are often supported by local manufacturers' representatives.

NON-STANDARD INDUSTRIAL

Non-standard devices provide SD card or USB flash drive functionality but do not use the standard form factors or connectors. They may be offered in either commercial or industrial versions.
Commercial versions typically utilise MLC NAND flash and support an operational temperature range that is consistent with consumer cards, for example -25°C to +85°C for SD devices.

Industrial versions support the full industrial temperature range of -40°C to +85°C and may be offered with MLC or SLC NAND flash.

The Datakey RUGGEDrive™ line is a great example of non-standard SD and USB flash drive devices.

Because the non-standard form factor can be employed as a security feature, these non-standard devices are typically not sold through the major electronic component distributors. A direct sales model is typically used to ensure controlled availability, where only authorised OEMs are allowed to purchase the devices. Non-standard devices are often supported by local manufacturer's representatives.

WHICH CATEGORY IS RIGHT FOR ME?

It very much depends on your application. We obviously supply non-standard industrial solutions, but we wouldn't always recommend them – the reality is that the correct choice will be dictated by the function.

WHEN IS STANDARD CONSUMER THE RIGHT CHOICE?
If cost is the most important factor in your choice of removable memory for your embedded system, then standard consumer could be the right option for you, especially if the embedded system is only going to be in production for a short period of time (say 1-2 years).

Another reason why you might opt for standard consumer would be if you need your customers to be able to obtain their own memory devices to use within the system easily – think an SD card for a DSLR camera. Standard consumer removable memory solutions are generally not very robust, so they're better in situations where there is unlikely to be wear on the connector, or if they are not going to be placed in environments with high vibration.

WHEN IS STANDARD INDUSTRIAL THE RIGHT CHOICE?

The reasons for opting for standard industrial are broadly the same as with standard consumer, but the one benefit of industrial over consumer is the reliability of the memory and the need for memory to operate in a wider temperature range.

Standard consumer removable memory simply isn't resilient to anything but ambient temperatures, so if that's a consideration, but the other reasons for choosing standard consumer still stand, then standard industrial could be the right 'halfway house' between standard consumer and non-standard industrial.

WHEN IS NON-STANDARD INDUSTRIAL THE RIGHT CHOICE?

While lesser known than their standard counterparts, non-standard USB flash drives and SD cards deliver a variety of benefits to embedded systems designs that use them.

Ideal for Security Conscious Organisations

Understandably, many military and government organisations view USB flash drives and SD cards with a high level of mistrust.

The concern is that these devices could be used (either intentionally or inadvertently) to take unauthorised sensitive, confidential or classified data off-site.

Additionally, these devices could bring in outside malware and infect internal PCs and systems. To remedy this problem, the devices are either banned or only certain approved devices may be used.

Using non-standard industrial memory is a potential solution to these sorts of problems.

The non-standard drive provides USB flash drive functionality for the embedded product, but does so without the previously-mentioned concerns, as it physically does not plug into standard PCs, instead only plugging into the proprietary receptacle on the embedded device.

Figure 1: A Datakey RUGGEDrive™ memory token

A physical layer of security

Figure 1 shows an example of a memory device that uses a non-standard form factor. The Datakey RUGGEDrive memory token can provide either USB flash drive or SD card functionality in the proprietary RUGGEDrive token form factor.

The RUGGEDrive token is roughly the size of a typical USB flash drive—about 2" long by 0.75" wide (51.5 mm x 18.4 mm). It mates with Datakey SlimLine board-mount and panel-mount receptacles and has redundant contacts on both sides of the token, so it can be inserted with either side up.

Crucially, the proprietary shape of the token means that it doesn't plug into any standard connectors.

On its own, a non-standard form factor certainly doesn't qualify as a robust security solution, but this simple physical-layer security feature can be sufficient to prevent access by those who lack the intention, the knowledge or motivation to circumvent it.

This same benefit also applies to the receptacle.

If a standard USB receptacle is used, a variety of different USB devices can physically plug into that port. With a proprietary receptacle, only the intended device will plug in, eliminating the need to address the different types of USB devices the port will support and reducing the chances that malware could be introduced.

It should be noted that there are times when data will need to be transferred from a non-standard device to a standard PC. For these cases, adapters are used, like the one shown in Figure 2. Like the non-standard memory devices, the availability of the adapters is also controlled, so they are only made available to those who should have them.

Figure 2: An adapter is used to allow a non-standard memory device to plug into a standard USB port

A singular device to qualify & support

When a system supports standard USB flash drives or SD cards it is difficult - or even impossible - to control which models users may plug in.

End users will likely expect that any device they choose will work with the system, provided the device physically fits. This means that the design team is more or less signing up to support every device that fits, past, present and future.

This can lead to more up-front engineering work and testing for the design team and increased support costs down the road. When using a non-standard flash drive or SD card, there is only one device to qualify and support leading to a quicker time-to-market and reduced support costs.

A higher level of robustness

When not forced to comply with the physical dimensions called for in the standard, a non-standard memory device can use alternative construction techniques and form-factors to produce a product that is much more physically robust.

The Datakey DFX RUGGEDrive memory token, for example, provides SD card functionality and uses solid over-molded construction. It is nearly three times as thick as a standard SD card and has been shown to withstand more than seven times more force in destructive testing1.
A chain is only as strong as its weakest link. Designers should make sure that the weak link in their removable memory system is not the USB connector.

Most 4-conductor USB Type A connectors are only rated for 1,500 insertion/removal cycles. At just 10 insertion/removals per day, a USB connector could exceed that specification in only five months.

As a point of comparison, the proprietary Datakey SlimLine receptacle is rated for at least 50,000 insertion/removal cycles. At the same rate, the Datakey receptacle would last for nearly 14 years.

Easier to insert

Both SD cards and USB flash drives (at least those that use USB Type A connectors) must be inserted in the proper orientation.

Forcing in a memory device, like an SD card, when it is inserted upside down can cause damage to both the memory device and the receptacle.

Not being tied to the standard form factor or connector, a non-standard memory device can utilise redundant contacts, so that it can be inserted with either side up.

YOUR NEXT APPLICATION?

We really hope you found this guide useful, and that it'll assist you in making the right decision for your next application.

With that in mind, we'd be delighted to offer you a completely free design consultation with one of our engineers, where you outline your next project, explain where your memory requirements area, and we can understand together whether Datakey products could be the right choice for you.

We will of course maintain all necessary security and secrecy, whether that's signing a non-disclosure agreement or simply ensuring that the information we discuss is not shared anywhere else.

Datakey

The power of memory. Secured.

How to Choose the Best Type of
Removable Memory Device for
your Embedded System

WHITE PAPER

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